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GEOPHYSICAL YEAR INFORMATION
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SOVIET BLOC INTERNATIONAL GEOPHYSICAL YEAR INFORMATION

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PLEASE NOTE

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Soviet IGY Program for Rockets and Artificial Earth Satellites

CPYRGHT The following is a full translation of the "Program of Investigations With the Aid of Rockets and Artificial Earth Satellites Planned by the Soviet Union for the IGY", as detailed in the official Soviet IGY Information Bulletin:

A. Introduction

One of the most important parts of the program of investigations being conducted during the International Geophysical Year is the study of the various geophysical phenomena occurring in the upper layers of the atmosphere.

In the program of works planned by the Soviet Union for the IGY investigations of the Earth's atmosphere, conducted with the aid of the launching of rockets and artificial Earth satellites, play an important role.

These investigations will make it possible to obtain authentic information on the structure of the Earth's atmosphere and the physical phenomena occurring in it, as well as data necessary for the solution of certain practical questions: improvement of the meteorological service, forecasting of radio-wave propagation conditions, the more precise determination of conditions for the flight of aircraft, etc.

Investigations of the upper atmosphere with the aid of rockets have been conducted in the USSR for a number of years. During the IGY, the continuation and further development of these works are proposed.

Great possibilities for the investigation of the upper atmosphere are presented in connection with the impending launching of artificial Earth satellites, with whose aid scientists will manage for a long period of time to conduct observations of the processes occurring in the upper atmosphere.

During the IGY, the launching of artificial Earth satellites for scientific purposes will be accomplished in the Soviet Union.

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At present, there is a great number of proposals of Soviet scientists concerning the utilization of rockets and artificial Earth satellites for conducting various measurements. These proposals embrace nearly all of the basic questions of physics of the upper layers of the atmosphere and certain other problems. The preliminary program of investigations is presented below.

B. Upper Atmosphere Phenomena To Be Investigated With the aid of Rockets and Artificial Earth Satellites

It is proposed to conduct a study of (1) the structural parameters of the atmosphere, (2) optical properties of the atmosphere, (3) ultra-violet and X-radiation of the Sun, (4) corpuscular radiation of the Sun and aurora, (5) cosmic rays, (6) ionospheric phenomena, (7) Earth's magnetic field, (8) micrometeoros and meteors, and (9) physicochemical processes in the upper layers of the atmosphere.

The essence of the investigations consists of the following:

1. Structural Parameters of the Atmosphere

Measurements will be conducted on pressure temperature and air density at various altitudes, as will the study of the composition of the atmosphere.

In connection with the measurements of density with the aid of manometers, certain data will be obtained on the basis of observations made of the satellite orbit.

Because of the resistance of the atmosphere, the satellite in its movement, will gradually approach the Earth. In studying its orbit, we may be able to find the law of distribution of air density at an altitude.

2. Optical Properties of the Atmosphere

Measurements will be made of the altitude and brightness of the luminescent layers of the atmosphere; a study will also be made of phenomena of light scattering in the atmosphere and of optical phenomena on the horizon.

3. Ultraviolet and X-radiation

The air shell is a filter for solar radiation.

The atmosphere permits the passage of ultraviolet radiation at a wave length of no less than 0.29μ .

The entry of rockets and satellites into the upper layers of the atmosphere will make it possible to conduct a study of the ultraviolet and X-ray parts of the solar spectrum and to evaluate the role of these solar emissions in the information of the ionosphere and absorption of radiation in the various layers of the upper atmosphere.

4. Corpuscular Radiation of the Sun and Aurora

Corpuscular radiation of the Sun causes great sporadic changes in the magnetic field of the Earth and in the ionosphere. Ionospheric disturbances caused by corpuscular solar streams lead to prolonged disturbances of short-wave radio communications

Solar corpuscles also cause some other phenomena in the upper layers, including aurora. However, the nature of corpuscular radiation and its intensity has been insufficiently studied. In this connection, it is planned to measure the intensity of corpuscular radiation of the Sun and to determine corpuscular particles and the speed of their intrusion into the Earth's atmosphere during a quiet Sun and at the time of great active processes on the Sun.

5. Cosmic Rays

It is known that primary cosmic radiation basically consists of hydrogen-nuclei (protons), helium nuclei (alpha particles), and a significantly lesser quantity of heavier nuclei (carbon, nitrogen, oxygen, etc.).

One of the properties of primary cosmic radiation is the similarity between the mean propagation curve of the elements of the universe and the distribution curve of charges of the primary component of cosmic radiation. Such elements as lithium, beryllium, and boron are rare in nature and the question concerning the quantity of the nuclei composition of primary cosmic radiation has not been solved experimentally as yet. In this connection, the study of the properties of primary cosmic radiation may throw light on the questions of the time of entry of cosmic particles into terrestrial space and on the origin of cosmic rays.

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To this group of problems should be added the study of the variations of intensity of cosmic rays at various altitudes and in different areas.

6. Ionospheric Phenomena

One of the problems bearing on the structure of ionospheric layers is the determination of the ion concentration which changes with altitude. In this connection, the obtaining of information on the ionization of the atmosphere along the orbit of a satellite or along the flight path of a rocket is of significant interest.

The study of radio-wave passage dealt with from a satellite or rocket passing through the ionospheric layers will make it possible to make more precise our data concerning electron density and the degree of radio-wave attenuation.

Mass-spectrometer measurements of the ion composition of the ionosphere to determine and make more precise its structure will also be accomplished.

7. Magnetic Fields

Short period fluctuations of the Earth's magnetic field at present are connected with the existence of electric currents in the upper layers of the atmosphere. According to contemporary data, a circle of such currents is located in the auroral zones (in the northern and southern latitudes) and around the Equator.

Confirmation of the existence of these currents and the obtaining of data on their nature and causes of formation are important tasks of scientific measurements from an artificial Earth satellite. The solution of this problem will place in the hands of scientists new data for clarifying different type short-period variations of the Earth's magnetic field and their relation to other geophysical phenomena and processes appearing on the Sun.

8. Micrometeors

The problem of micrometeors has great scientific and practical significance. On the one side, the phenomenon of micrometeors in the upper atmosphere depends on a whole number of physical processes influencing the state of the atmosphere. On the other hand, micrometeors, like

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meteors, present a danger to an artificial Earth satellite. Calculations indicate that even the smallest particles, moving with velocities of 50-70 km/sec, are capable of puncturing the exterior skin of a satellite. Therefore, it is essential to know the concentration in space and the energy of micrometeors. A study of the spectrum of micrometeors and meteors according to their mass would make it possible to draw a specific conclusion concerning "meteor danger" -- an extremely important problem for future interplanetary travel. For the solution of this task, instruments recording the encounters with micrometeors and the energy of collisions will be installed on rockets and satellites.

9. Physicochemical Processes in the Upper Layers of the Atmosphere

It is planned to eject from rockets in the upper layers of the atmosphere various chemical reagents and to study the processes originating during their interaction with the surrounding medium.

C. Ascents of Apparatus on Rockets and Satellites

All geophysical apparatus intended for investigating the upper layers of the atmosphere will be located in rockets in containers of various types or in a satellite.

The containers are made of metallic casings containing instruments and are ejected from the rocket at a specified altitude. Rockets or containers can achieve an altitude of 200 kilometers.

Containers are equipped with radiotelemetry or instruments with direct photographic recording. In the latter case, recovery of the containers will be accomplished.

D. Rocket Launching Sites

Vertical launching of rockets to investigate the upper layers of the atmosphere is planned for three zones situated approximately at 50-60° East Longitude:

First zone -- Arctic, Franz Josef Land, 80° North Latitude

Second zone -- Middle latitudes of the USSR, 50-60° middle latitude

Third zone -- Antarctic, chiefly in the region of the Mirnyy Antarctic Observatory, 50-60° South Latitude.

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It is planned to make a launching of an artificial Earth satellite from the territory of the USSR at a slight angle to the meridian. A satellite launched in such a way and revolving around the Earth will be observed consecutively in all regions of the Earth, excluding the Central Arctic and the Antarctic.

E. Distribution of Rockets According to Zones and Years

The number of rocket launchings according to zone and year are distributed as follows:

In the first zone, 25 launchings will be made in 1958; in the second zone, 30 launchings will be made in 1957 and 40 launchings in 1958; and, in the third zone, 30 launchings will be made during 1957-1958.

F. Distribution of Parameters Being Investigated by Containers

In each launching of rockets or artificial Earth satellites, a specific complex of investigations in the upper atmosphere will be accomplished.

In rocket ascents of containers of one type, investigations of the structural parameters of the atmosphere and its optical properties, ultraviolet and X-ray parts of the solar spectrum, ionospheric phenomena, and micrometeors will be conducted.

In rocket ascents of containers of another type, the complex of investigations will be expanded and the study of the corpuscular radiation of the Sun and aurora, as well as of the physicochemical processes in the upper layers of the atmosphere will also be made.

In the launching of artificial Earth satellites, the program of scientific investigations consists of geophysical, physical, and astrophysical experiments and various combinations of these, as well as other investigations, as for example, the observation of the effect of the theory of relativity, study of the earth's form, etc.

G. Order of Launchings

The launching of rockets and satellites will be conducted during the IGY, chiefly on days of international observations in connection with active processes on the Sun. (Mezhdunarodnyy Geofizicheskiy God, Informatsionnyy Byulleten', No 3, 1957, pp 32-36)

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II. UPPER ATMOSPHERE

Soviets Report First Results of Upper Atmosphere Observations

The temperature of the atmosphere at an altitude of around 100 kilometers gradually increases in a northerly direction, changing approximately from 200° K in the south to 400° K in polar regions. Certain upper atmosphere emissions testify to the essential role of helium in geomagnetic and ionospheric disturbances and in aurora.

These and other first results of upper atmosphere observations made by the USSR during the first 6 months of the IGY are reported by V. I. Krasovskiy, Doctor of Physicomathematical Sciences and a member of the Institute of Physics of the Atmosphere of the academy of Sciences USSR in Moscow, in a leading journal of the academy. According to Krasovskiy, the Institute of Physics of the Atmosphere began observations according to the IGY program at three of its stations, located in Loparskaya near Murmansk, Roshchino near Leningrad, and at Zvenigorod near Moscow. Observations of upper atmosphere emissions and radar reflections from aurora enter into this program. At present radar observations are being successfully made at Loparskaya and Roshchino. In July, in the polar regions, it was light, and optical observations were impossible. However in Roshchino, on the eve of the IGY, in spite of the "white" night, traces of aurora emissions were recorded. Detailed spectra of emissions were obtained in Zvenigorod, which is located further to the south, where the night was darker.

Rotating-oscillating spectra of the hydroxyl in night sky brightness, says Krasovskiy, indicates that the temperature of the atmosphere at an altitude of around 100 km gradually increases in an orderly direction, changing approximately from 200° K in the south to 400° K in polar regions. During nearly all of the aurora observed, the emission of hydrogen of non-terrestrial origin was recorded. The contour of spectral lines of hydrogen testified to the fact that the hydrogen corpuscles being emitted have a speed approaching 1,000-2,000 km per sec. Hydrogen emission has a tendency to be intensified in the much lower latitudes.

From theory and laboratory experiment, it follows that even in the case of identical intensity and energy of irradiating corpuscles in the air, helium particles radiate significantly weaker than hydrogen particles. Therefore, it is no wonder that the radiation of helium cannot be detected, even in aurora, in whose spectra, however, are found intensive emissions of ionized atomic nitrogen, which originates during bombardment of the air by helium corpuscles and which is lacking during equivalent hydrogen excitation. The emissions indicated testify to the essential role of helium in geomagnetic and ionospheric disturbances and in aurora. The type of spectra obtained depend basically on the altitude at which the emissions occur.

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As a result of observations, the compiled collection of spectra makes it possible to estimate the intensity of separate emissions, for example, the hydroxyl emission in the near infrared region of the spectrum. With the aid of a 180° wide-angle automatic camera, motion-picture film of aurora was obtained. The interesting structure of brightness and its change in space and time was manifested. It is interesting that the predominant part of auroral emission was concentrated in much weaker, extensive, diffused forms surrounding bright formations and not in the formations as generally supposed. Valuable material for theoretical investigation was obtained.

Radar reflections of aurora at short waves, to 3-4 meters, being observed at distances from 100 to 1,000 kilometers, make it possible to conclude that at the time of geomagnetic, ionospheric disturbances and aurora, highly nonhomogeneous ionization takes place, and the density of free electrons in separate zones reaches 10^8 cm^{-3} . Reflections of aurora with increasing or decreasing distance are especially interesting. Ya. G. Birfel'd, who earlier described these reflections and their corresponding reflected signals, assumed that these reflections were from aurora at distances exceeding 1,000 km. It was assumed that the variable distance was related to the change of properties of the ionosphere. From the beginning of regular observations in Roschino, such variable reflections according to distance, are recorded in the azimuth of Loparskaya, where, during aurora, the radar switches in on this same wave length every 15 minutes. Simultaneously, the reflections at a fixed distance from other azimuths are sometimes recorded. All of this now provides a basis for assuming that the reflected signals are obtained as a result of the reception of radio pulses from remote radar sets where AC frequency oscillations in electrical circuits of radar stations take place.

Our investigations, Krasovskiy reports, are directed chiefly toward the clarification of elementary microprocesses of the upper atmosphere and the nature of the agents disturbing them. During the IGY, conclusions based on observations of solar activity, variations of the magnetic field, and currents of the Earth, meteors, ionospheric soundings, as well as on data obtained with the aid of rockets and artificial Earth satellites, will be made on the condition of the upper atmosphere.

However, the majority of anticipated information touches on macroscopic properties and processes. Without the observations being conducted by us, it is impossible to draw out purely correlated comparisons of various phenomena and to create an exhaustive and physically based single theory of all processes of the upper atmosphere. The investigations being conducted have a major scientific and practical significance. For example, observations of hydrogen emission in the visible part of the spectrum make it possible to follow at the same time the more powerful hydrogen emission accompanying it in the region of solid ultraviolet ($\lambda = 1200 \text{ \AA}$). As is known, this emission (HL_α) ionizes in the atmosphere below 100 kilometers,

increasing the absorption of short radio waves, which leads to an interruption of communications. Together with these observations of radar reflections from the aurora, it becomes evident that at the time of geomagnetic and ionospheric disturbances, communications are entirely possible on another shorter wave band of 3-10 meters, which, under usual conditions (for example in television) reliable ensures communications at a distance only in the limits of direct visibility. This has great significance for the organization of regular radio communications in polar regions. (Priroda, No 12, Dec 57, pp 87-88)

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New Soviet Radio Telescope in Operation in Crimea

A preliminary report on a new, large radiotelescope on which construction began in July 1957 at the Crimean Scientific Station of the Physics Institute of the Academy of Sciences USSR has been published in one of the leading Soviet radio engineering and electronic journals by V. V. Vitkevich and V. A. Udal'tsov.

The new radio telescope is a 31 m diameter parabolic dish dug out of the earth, concreted, and metallized. Actually it is constructed on the base of one of two parabolic reflectors in the form of earthen dishes which were constructed prior to 1956 to investigate the solar corona by the "translucence" method. To make radio reception of shorter waves down to the centimeter range possible, a special templet was made, placed in the dish, and rotated on an axis coinciding with the axis of the parabolic dish. The surface of the dish was covered with concrete, in which, until its final hardening, the templet rotated, giving it an appropriate form. An accuracy of around one centimeter was achieved in finishing the surface. Then the dish was metal-coated by spraying zinc on it. Eng M. M. Tyaptin supervised the construction part of the work.

A movable carriage of special design was installed in the focus. This carriage makes it possible to control the directivity pattern of the antenna, as well as to track in certain limits the source on which observations are being made. The axis of the parabolic reflector is in a meridian plane and is oriented at a declination of $\neq 22^{\circ}$. Such a position of the axis ensures the possibility of conducting a varied program of observations.

First, it will be possible, over a wide radio-wave range, to study the radio frequency emission of the source Taurus-A identified with the Crab nebula. On centimeter wave lengths, investigations of the super-corona of the Sun will be accomplished during its "translucence" by radio waves from the Crab nebula which, annually, in mid-June, is covered by the solar corona.

Secondly, with the aid of this radiotelescope in the area of declinations close to 22° , radio frequency emission of the Galaxy, Metagalaxy, and individual discrete sources will be studied in detail in the centimeter and decimeter wave range. The telescope will make it possible to study radio emission of the Sun, Moon, and possibly a planet with a high degree of resolution.

With the aid of this radiotelescope, preliminary observations have been made of the radio emission of the Sun and Crab nebula on the 50- and 10-cm band and of solar radio emission of the 3-cm band. The width of the antenna radiation pattern obtained on the basis of these observations, was shown to be close to the theoretical ($16'$ at $\lambda = 10$ cm). An estimate of the flow of radio emission from the Crab nebula for $\lambda = 50$ cm gives a value of approximately $13 \cdot 10^{-24}$ watts/m²/cycle.

At present, the electrical characteristics of the radio telescope are being studied and preparations for systematic observations are being made. The authors conclude their report with the promise that a detailed description of the new radio telescope will be published in the future. (Radiotekhnika i Elektronika, No 12, Dec 57, pp 1,548-1,549)

111. OCEANOGRAPHY

Vityaz' Trawls 10,800-Meter Depth; Visits New Zealand

Soviet scientists aboard the Vityaz' have successfully trawled the Kermadec deep-water depression to a depth of 10,800 meters. Around 15 species of the sea depths, including several species heretofore unknown to science, were brought to the surface. (Moscow, Izvestiya, 16 Jan 58)

On 20 November 1957, the Vityaz' crossed the Tropic of Cancer and several days later was in the region of the Hawaiian Islands. This is the 26th voyage, the second during the IOY, of the expeditionary ship of the Institute of Oceanology of the Academy of Sciences USSR. This particular expedition, headed by Prof V. G. Bogorov, a leading oceanologist, is studying the distribution of water masses, bottom relief, and the life in the ocean. Current measurements with the aid of an electromagnetic self-recorder, designed in the Institute of Oceanology, were successfully made.

In the little more than 2 weeks of this second IOY voyage, the Vityaz' obtained very valuable new data; for example, on the propagation of the Kuroshio warm current [Japan Current]. On the voyage from Japan to the Hawaiian Islands, the Cololabis saira fish were seen by the expedition. (Moscow, Vechernyaya Moskva, 25 Nov 57)

A 24 January 1958 newspaper article reports on the Vityaz's visit to Wellington, the capital of New Zealand. While docked in Wellington, a conference devoted to the work of the Institute of Oceanology being conducted aboard the Vityaz' was organized jointly with the scientists of Wellington. Two papers were delivered in a local museum and ten papers were read aboard the Vityaz' in three sections. All papers were presented by the Soviet scientists in English and generated a lively exchange of opinions. The local scientists spoke on the great contributions which the Soviet scientists made to our understanding of the ocean.

The Soviet scientists became acquainted with the scientific works being conducted by the New Zealand Institute of Oceanography, the university, meteorological observatory, and the center for nuclear research.

More than 100 New Zealand scientists participated in the works of the conference, and more than 2,000 persons visited the Vityaz' in 4 days. On 18 January, the Vityaz' sailed from Wellington and is continuing its scientific work in the Pacific Ocean. (Moscow, Pravda, 24 Jan 58)

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Study on Temperature Variations in Surface Layer of the Sea

The results of the simultaneous registration of temperature and pressure variations at one point in the surface layer of the sea are presented in a report entitled "Temperature Variations in the Surface Layer of the Sea Caused by Wave Disturbance," by G. Ye. Kononkova and N. V. Kontoboytseva of Moscow State University imeni M. V. Lomonosov. The presence of temperature variations with periods coinciding with wave periods and with phases either coinciding with phases of waves or relatively displacing them by 180° are established. It is shown that these temperature variations are dependent on the arrival at the point of observation of wave disturbances of water layers from different levels. (Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 12, Dec 57, pp 1,473-1,483)

Depths of Shallow Water Measured by Photometric Method

A photometric method of determining depths of sea shallows which provides an analysis of both the photometric as well as the geometric properties of aerial photographs is presented in a work by D. A. Yanutsh. The basis of this method is the relationship between the depths of the water basin and the optical plane of its representation on the aerial photograph. An equation is derived for the relationship between the photographic brightness of a water basin and its depth. Aerial surveying is carried out in two spectral ranges, red and green, using two cameras, permitting the determination of depths under laboratory conditions with complete absence of directly measured depths.

Practical use of the described method is made in the making of coastal measurements of depths as well as in the reconnaissance of hard-to-reach water basins. (Zhurnal Nauchnoy i Prikladnoy Fotografii i Kinematografii, Vol 2, No 6, Nov-Dec 57, pp 450-458)

IV. SEISMOLOGY

Study on Deep Seismic Soundings of the Earth's Crust

The problem of the correlation detection of seismic waves and groups of waves which are registered in deep seismic sounding of the Earth's crust is considered in a report by P. S. Veytsman of the Institute of Physics of the Earth, Academy of Sciences USSR. Groups of waves connected with the principal seismic boundaries in the Earth's crust are distinguished on seismograms. The waves of different groups differ in a number of stable kinematic and dynamic characteristics. On the basis of an analysis of these features, criteria for the separation and identification

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of groups of waves registered in separate profiles are formulated. The principles of group correlation permit carrying out the joint interpretation of the seismic registrations, obtained in a system of profiles located in the limits of 100 kilometers from the point of the explosion and at a distance of 10 kilometers between profiles.

Experimental work on deep seismic sounding showed that the basis of the methods of interpretation, developed mainly for conditions in Tien Shan, are also applicable in other regions having a different structure.

A bibliography of 29 Soviet and foreign sources is given. Fifteen of these are by G. A. Gamburgsev. (Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 12, Dec 57, pp 1,438-1,452)

Soviets Introduce New Methods in Seismology

G. A. Gamburgsev and Yu. V. Ryznichenko report on certain new methods of seismological investigations used under the direction and leadership of Gamburgsev by a number of Soviet seismologists of the Geophysics Institute of the Academy of Sciences USSR in collaboration with the academies of sciences of some of the union republics (Georgian, Azerbaydzhan, Turkmen, and others).

The first of these methods is the idea of an azimuthal phase correlation of seismic waves based on the use of azimuthal seismic stations which consist of a group of differently oriented seismographs having a single location point. A variation of the azimuthal station was the use of an "inclined" seismograph, by means of which the component of soil movements along certain inclined axes are registered. The azimuthal method easily enables the visual separation of longitudinal, transverse, and surface waves on a background of irregular wave disturbances and also enables one to distinguish simple waves from waves distorted by interference. This is based on the stability of polarization of the oscillations with respect to time. In addition, this method requires only one point of observation in contrast to usual methods of seismic prospecting, which may require two or more points of observation due to profile.

The second was the method developed for a more complete study of seismic phenomena. This consisted in widening the frequency range in the registration of earthquakes. In this connection, a new instrument was developed called the seismoinclinometer; with this, low-frequency oscillations were recorded. This instrument differs from inclinometers in that it measures the speed of changes in the inclines rather than the inclines themselves.

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The third development of Gamburgaev resulted in a method of deep seismic sounding of the Earth's crust based on correlation principles of registering artificially created seismic waves. Results of this work led to such information on the characteristics of the deep geological structure of certain mountain and foothill regions. The results indicated the possibility of significantly increasing the details of studying deep layers of the Earth's crust.

Riznichenko, in his supplement to Gamburgaev's article, reviews the latter's work and its continuation at present. In this connection, he mentions the relation established between the structure of the Earth's crust and the character of the gravimetric field in the region of northern Pamir. Experimental work in the central part of the Caspian Sea to develop methods of deep seismic sounding in the sea was carried out in 1956 by the Institute of Physics of the Earth, Academy of Sciences USSR in collaboration with other organizations. At present, expeditionary work is being done in the study of the Earth's crust in the transition zone between the Asiatic continent and the Pacific Ocean in the region of the Okhotsk Sea and the western part of the Pacific Ocean.

All the investigations of earthquakes and the structure of the Earth's crust were and are being made by seismic methods and other geophysical methods (gravimetry, magnetometry, etc.) and accompanied by geological investigations.

Riznichenko states that the methods of deep seismic sounding of the Earth's crust on land and also the methods of studying weak local earthquakes as developed in the USSR are more accurate and detailed than methods of this type being applied abroad. However, he admits that in a number of important problems, the level of seismic investigations in the USSR is below that of certain foreign countries such as Japan, where for example, there is a lead in the development of methods of observing earthquakes in the field of low frequency oscillations, and in the US and Great Britain, where there is a lead in methods of studying the structure of the Earth's crust in the seas and oceans. (Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 12, Dec 57, pp 1.431-1.437)

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